

CLAIMS

1. An ultrasonic diagnostic apparatus, comprising:
 - 5 a transmission unit that transmits at least one ultrasonic pulse from a skin surface of a subject toward a blood vessel thereof;
 - 10 a reception unit that receives an ultrasonic echo reflected by the blood vessel and converts the same into an electric signal to obtain a signal of the ultrasonic echo along a depth direction from the skin surface;
 - 15 a movement detection unit that analyzes a phase of the ultrasonic echo signal in a direction traversing the blood vessel so as to calculate a movement amount in each of a plurality of parts included in a blood vessel wall constituting the blood vessel and a vicinity of the blood vessel wall; and
 - 20 a boundary detection unit that detects a boundary position between the blood vessel wall and a blood flow region in a lumen of the blood vessel through which blood flows based on a variation in the calculated movement amount in each part.
 2. The ultrasonic diagnostic apparatus according to claim 1, further comprising a ROI placement unit that sets placement of a ROI where the boundary position along the depth direction from the skin surface is to be detected by the boundary detection unit,
 - 25 wherein the ROI placement unit places the ROI so as to lie over at least one of an anterior wall of the blood vessel wall on a side closer to the transmission unit and a posterior wall of the blood vessel wall on a side farther from the transmission unit.
 3. The ultrasonic diagnostic apparatus according to claim 1 or 2, wherein the transmission unit transmits a plurality of ultrasonic pulses toward a plurality of parts along a longitudinal direction of the blood vessel, and

the boundary position detection unit detects the boundary position for each of the plurality of parts along the longitudinal direction of the blood vessel.

- 5 4. The ultrasonic diagnostic apparatus according to claim 3, further comprising a filter processing unit that performs filter processing of data representing the boundary position along the longitudinal direction of the blood vessel that is detected by the boundary position detection unit.
- 10 5. The ultrasonic diagnostic apparatus according to claim 3 or 4, further comprising a display unit that displays an image of the blood vessel in cross section along the longitudinal direction of the blood vessel based on the boundary position along the longitudinal direction of the blood vessel that is detected by the boundary position detection unit.
- 15 6. The ultrasonic diagnostic apparatus according to any one of claims 1 to 5, further comprising an average processing unit that performs average processing of data representing the boundary position that is detected by the boundary position detection unit based on data representing a boundary position obtained a predetermined number or more of measurement cycles before.
- 20 7. The ultrasonic diagnostic apparatus according to claim 6, wherein the measurement cycles include a heartbeat cycle of a blood flow that flows through the blood vessel.
- 25 8. The ultrasonic diagnostic apparatus according to any one of claims 1 to 7, further comprising an average processing unit that performs average processing of data representing the movement amount of the blood vessel wall that is detected by the movement detection unit based on data

representing a movement amount obtained a predetermined number or more of measurement cycles before.

9. An ultrasonic diagnostic apparatus, comprising:

5 a transmission unit that transmits at least one ultrasonic pulse from a skin surface of a subject toward a blood vessel thereof;

a reception unit that receives an ultrasonic echo reflected by the blood vessel and converts the same into an electric signal to obtain a signal of the ultrasonic echo along a depth direction from the skin surface;

10 a movement detection unit that analyzes a phase of the ultrasonic echo signal in a direction traversing the blood vessel so as to calculate a movement amount in each of a plurality of parts included in a blood vessel wall constituting the blood vessel and a vicinity of the blood vessel wall; and

15 a boundary detection unit that detects a boundary position between an inner membrane of the blood vessel and a blood flow region in a lumen of the blood vessel through which blood flows and a position of a middle membrane of the blood vessel based on a variation in the calculated movement amount in each part.

20 10. The ultrasonic diagnostic apparatus according to claim 9, further comprising a ROI placement unit that sets placement of a ROI where the boundary position between the inner membrane of the blood vessel and the blood flow region and the position of the middle membrane are to be detected along the depth direction from the skin surface by the boundary detection 25 unit,

wherein the ROI placement unit places the ROI so as to lie over at least one of an anterior wall of the blood vessel wall on a side closer to the transmission unit and a posterior wall of the blood vessel wall on a side farther from the transmission unit.

11. The ultrasonic diagnostic apparatus according to claim 9 or 10, further comprising a calculation unit that measures a thickness from the inner membrane to the middle membrane based on the boundary position and the position of the middle membrane.

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12. The ultrasonic diagnostic apparatus according to claim 11, wherein the calculation unit measures the thickness from the inner membrane to the middle membrane based on a variation over time in the boundary position and a variation over time in the position of the middle membrane in one

10 heartbeat cycle.

13. The ultrasonic diagnostic apparatus according to claim 12, wherein the calculation unit calculates at least one of a maximum value, a minimum value and an average value of the thickness in one heartbeat cycle.

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14. The ultrasonic diagnostic apparatus according to any one of claims 11 to 13, wherein the transmission unit transmits the plurality of the ultrasonic pulses toward the plurality of parts along the longitudinal direction of the blood vessel, and

20 the calculation unit measures the thickness at each of the plurality of parts.

15. The ultrasonic diagnostic apparatus according to any one of claims 11 to 14, further comprising a display unit that displays a part where a
25 maximum thickness is measured among the thicknesses measured at the plurality of parts.

16. The ultrasonic diagnostic apparatus according to any one of claims 9 to 15, further comprising an angle correction unit that performs angle

30 correction with respect to a value of the thickness corresponding to an angle

formed between a measuring direction of the thickness calculated by the calculation unit and a direction perpendicular to the blood vessel wall.

17. The ultrasonic diagnostic apparatus according to any one of claims 9
5 to 16, further comprising a stability determination unit that determines stability of the thickness calculated by the calculation unit by comparing the thickness calculated by the calculation unit with a thickness obtained a predetermined number or more of cycles before.

10 18. The ultrasonic diagnostic apparatus according to any one of claims 9 to 16,

wherein the transmission unit transmits a plurality of the ultrasonic pulses toward a plurality of parts along a longitudinal direction of the blood vessel,

15 the calculation unit measures the thickness at each of the plurality of parts, and

the ultrasonic diagnostic apparatus further comprises a stability determination unit that determines stability of the thickness calculated by the calculation unit by comparing the thicknesses measured at the plurality of parts with each other.

19. The ultrasonic diagnostic apparatus according to any one of claims 11 to 18, further comprising a unit that displays a value of the thickness calculated by the calculation unit on a monitor.

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20. The ultrasonic diagnostic apparatus according to any one of claims 9 to 19, further comprising a unit that displays the boundary position and the position of the middle membrane detected by the boundary detection unit on a monitor.

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